SPACE OPTICS RESEARCH LABS

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Off-Axis Parabolic Mirrors (OAP)

Standard mirrors are listed on the following pages. SORL has a considerable selection of off-axis and other versions that may prove suitable for your intended designs and systems.

Specifying an Off-Axis Parabolic Mirror (OAP) *(Also see the note and drawing below and on page 5.)*

Since not all our standard mirrors may fit a given application, we also supply custom made versions. When describing a custom made off-axis parabolic mirror, the following parameters should be specified.

1. **Material:** Zerodur® Zero thermal-expansion glass-ceramic is the most stable material and is our standard. Alternatives include Fused Silica, ULE glasses, conventional metals, and light weight substrates.
2. **Focal Length:** True parabolic or vertex focal length, measured along optical axis from the vertex to the focus should be specified. The apparent focal length, measured from the mirror center to the focal point, may also be specified if desired. (See note and drawing below.)
3. **Off-Axis Distance:** Specified along a perpendicular from optical axis to inner edge of mirror.
4. **Outer Diameter:** Size of mirror to outer edge, compatible with physical requirements.
5. **Clear Aperture:** The optically qualified and utilized area of the mirror surface.
6. **Edge Thickness:** To insure structural stability, a mirror will typically be made from a blank having a 6:1 diameter-to-thickness ratio. For stand-alone mirrors, this is approximately correct. Off-axis parabolic mirrors sectioned from a larger diameter parent mirror may be thicker.
7. **Optical Performance:** **Surface Accuracy** - Deviation from perfect parabolic shape can be specified in any unit used for the measurement of length. The wavelength of helium-neon laser light (typically 0.6328 μ) is most commonly employed in the optics industry.

   Two quantities are usually given: (1) A "peak-to-peak" (peak-to-valley) value, specified in multiples (fractions) of the test wavelength, limiting maximum departure from true parabolic surface; and (2) A "slope error" figure (θ), measured in fractions of the test wavelengths per inch. Due to reflection at the surface, the interferometrically observed wavefront error is seen as twice the actual surface error for either "peak-to-peak" or "slope error" values.

   Mirrors specified by surface accuracy must be measured interferometrically to guarantee compliance.
8. **Surface Quality of Finish:** A measure of the optical polish, specified by "scratch/dig" values denoting surface imperfections, as defined by Military specifications, MIL-M-13508C. Typical specifications:

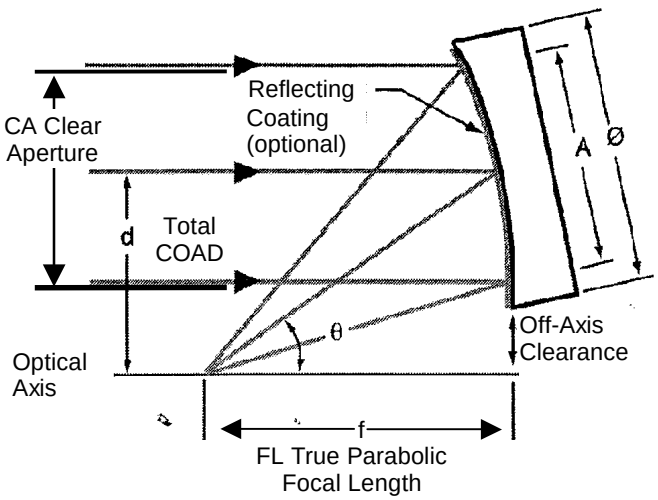
Scratch/Dig: 80/50 Commercial or, standard IR quality
60/40 More optimum, visible region
40/20 Visible laser applications
20/10 High power laser and UV (VUV) components

9. **Optical Coatings:** May be selected from a variety of metals that can be evaporated and dielectric materials. Considerations include optimal performance in a wavelength region of interest, optical power level, and environment of intended operation.
   - Aluminum Silicon Oxide (AlSiO) is a most durable coating and has high reflectivity from Visible through the IR
   - Enhanced aluminum (Al) has higher average reflectivity, but is less durable
   - Enhanced silver (Ag) is better for higher power and has higher average reflectivity from visible through the IR, but is also less durable
   - Gold (Au) for IR and VUV. Also platinum (Pt); OSMIUM (Os); lawrencium Lr; tungsten (W)
   - Aluminum with magnesium fluoride (Al/Mgf2) overcoat for UV applications (see coating section)

We will help customers develop specifications from the following basic requirements:

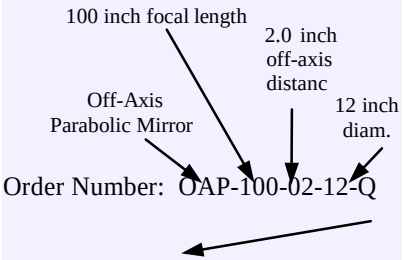
- What size the collimated beam should have. This is given as CA (clear aperture)
- What apparent FL (Focal Length) you require. Focal length influences the F/number.
- In addition state desired angle μ or COAD (centric off axis distance).

Note that the D (diameter) normally exceeds the diameter of the CA (clear aperture). Since space for mirror mounting, etc., has to be provided, our listing of standard mirrors shows the typical oversize for given CA (clear aperture). Please do not hesitate to call with any questions. (see also page 5 drawing)



NOTE:

Ordering Information Example:



Standard Off-Axis Parabolic Mirrors

The off-axis parabolic mirror charts list SORL's broad range of standard OAPs. SORL meets both standard and specialized specifications. SORL's technical team is always available to provide assistance.

Our standard Off-Axis Parabolic Mirrors offer:

- Wide selection of focal lengths, diameters, and off-axis distances
- Zerodur®, a precision, low thermal-expansion glass-ceramic material for long term reliability and stability in performance
- High quality λ/8 surface accuracy best performance for IR, visible and UV applications.
- Highly reflective AlSiO coating is standard. Other coatings for high durability and UV through IR performance are available. (see coating section)

Quality Assurance

- Accurate measurements of all critical dimensions and param-eters
- Test and alignment procedures furnished if ordered with mount
- Interferograms and data analysis supplied on request

	Focal Length				Off-Axis Distance			Mirror Diameter		Clear Aperture		Outer Edge Thickness*		Optical Performance		Parent Mirror Usable Diameter	
	True Parabolic		Apparent		Inner Edge		Angle to Center							Standard Quality	High Quality "-Q"		
Order Number	in	mm	in	mm	in	mm	degree	in	mm	in	mm	in	mm	millirad.	Surface Accuracy	in	mm
OAP-100-04-24	100	2540	100.6	2555	4.0	102	9.1	24.0	610	23.5	597	4.00	102	…	λ/8	Stand Alone	
OAP-100-02-16	100	2540	100.3	2540	2.0	51	5.7	16.0	406	15.5	394	2.70	69	…	λ/8	Stand Alone	
OAP-100-16-16	100	2540	101.4	2565	16.0	406	13.7	16.0	406	15.5	394	2.70	69	…	λ/8	Stand Alone	
OAP-100-02-14	100	2540	100.2	2544	2.0	51	5.2	14.0	356	13.5	343	2.35	60	…	λ/8	Stand Alone	
OAP-100-02-12	100	2540	100.2	2544	2.0	51	4.6	12.0	305	11.5	292	2.00	51	…	λ/8	Stand Alone	
OAP-100-04-10	100	2540	100.2	2544	4.0	102	5.2	10.0	254	9.8	249	3.00	76	…	λ/8	28.0	711
OAP-100-02-10	100	2540	100.1	2543	2.0	51	4.0	10.0	254	9.6	244	1.67	42	…	λ/8	Stand Alone	
OAP-100-02-08	100	2540	100.1	2543	2.0	51	3.4	8.0	204	7.9	201	2.05	52	…	λ/8	24.0	610
OAP-100-04-08	100	2540	100.2	2544	4.0	102	4.6	8.0	204	7.9	201	2.16	55	…	λ/8	24.0	610
OAP-100-06-08	100	2540	100.3	2548	6.0	153	5.7.	8.0	204	7.9	201	2.96	75	…	λ/8	28.0	711
OAP-100-08-06	100	2540	100.3	2548	8.0	204	6.3	6.0	153	5.9	150	2.96	75	…	λ/8	28.0	711
OAP-100-06-06	100	2540	100.2	2544	6.0	153	5.2	6.0	153	5.9	150	2.16	55	…	λ/8	24.0	610
																Stand Alone	
OAP-80-02-12	80	2032	80.2	2037	2.0	51	5.8	12.0	305	11.8	300	3.00	76	…	λ/8	28.0	711
OAP-80-04-10	80	2032	80.3	2040	4.0	102	6.4	10.0	254	9.8	249	3.00	76	…	λ/8	28.0	711
OAP-80-02-10	80	2032	80.2	2037	2.0	51	5.0	10.0	254	9.8	249	2.20	56	…	λ/8	24.0	610
OAP-80-06-08	80	2032	80.3	2040	6.0	153	7.2	8.0	204	7.9	201	3.00	76	…	λ/8	28.0	711
OAP-80-04-08	80	2032	80.2	2037	4.0	102	5.7	8.0	204	7.9	201	2.20	56	…	λ/8	24.0	610
OAP-80-08-06	80	2032	80.4	2042	8.0	204	7.9	6.0	153	5.9	150	3.00	76	…	λ/8	28.0	711
OAP-80-04-06	80	2032	80.3	2040	6.0	153	6.4	6.0	153	5.9	150	2.16	55	…	λ/8	24.0	610
OAP-80-06-06	80	2032	80.3	2040	6.0	153	6.4	6.0	153	5.9	150	2.20	56	…	λ/8	24.0	610
OAP-80-08-04	80	2032	80.3	2040	8.0	204	7.1	4.0	102	3.9	99	2.20	56	…	λ/8	24.0	610

Order Number	Focal Length: True Parabolic in	True Parabolic mm	Apparent in	Apparent mm	Off-Axis Distance: Inner Edge in	Inner Edge cm	Angle to Center degree	Mirror Diameter in	Mirror Diameter mm	Clear Aperture in	Clear Aperture mm	Outer Edge Thickness* in	Outer Edge Thickness* mm	Optical Performance: Standard Quality millirad.	High Quality "-Q" Surface Accuracy	Parent Mirror Usable Diameter in	Parent Mirror Usable Diameter mm
OAP-60-02-16	60	1524	60.4	1534	2.0	51	9.5	16.0	406	15.5	394	2.70	69	…	λ/8	Stand Alone	
OAP-60-02-12	60	1524	60.3	1532	2.0	51	7.6	12.0	305	11.5	292	2.00	51	…	λ/8	Stand Alone	
OAP-60-02-10	60	1524	60.2	1529	2.0	51	6.7	10.0	254	9.6	244	1.67	42	…	λ/8	Stand Alone	
OAP-60-04-10	60	1524	60.3	1532	4.0	102	8.6	10.0	254	9.8	249	2.94	75	…	λ/8	28.0	711
OAP-60-06-08	60	1524	60.4	1534	6.0	153	9.5	8.0	204	7.9	201	2.94	75	…	λ/8	28.0	711
OAP-60-04-08	60	1524	60.3	1532	4.0	102	7.6	8.0	204	7.9	201	2.05	52	…	λ/8	24.0	610
OAP-60-08-06	60	1524	60.5	1537	8.0	204	10.5	6.0	153	5.9	150	2.94	75	…	λ/8	28.0	711
OAP-60-06-06	60	1524	60.3	1532	6.0	153	8.6	6.0	153	5.9	150	2.05	52	…	λ/8	24.0	610
OAP-60-04-06	60	1524	60.2	1529	4.0	102	6.7	6.0	153	5.9	150	1.87	47	…	λ/8	24.0	610
OAP-60-08-04	60	1524	60.4	1534	8.0	204	9.5	4.0	102	3.9	99	2.05	52	…	λ/8	24.0	610
OAP-60-10-04	60	1524	60.6	1539	10.0	254	11.4	4.0	102	3.9	99	2.94	75	…	λ/8	28.0	711
							11.4										
OAP-40-04-10	40	1016	40.5	1029	4.0	102	12.8	10.0	254	9.8	249	3.21	82	0.1	λ/8	28.0	711
OAP-40-06-08	40	1016	40.6	1031	6.0	153	14.3	8.0	204	7.9	201	3.21	82	0.1	λ/8	28.0	711
OAP-40-015-08	40	1016	40.2	1021	1.5	38	7.9	8.0	204	7.9	201	1.94	49	0.1	λ/8	19.0	483
OAP-40-08-06	40	1016	40.8	1036	8.0	203	15.7	6.0	152	5.9	150	3.21	82	0.1	λ/8	19.0	483
OAP-40-035-06	40	1016	40.3	1024	3.5	89	9.3	6.0	152	5.9	150	1.94	49	0.1	λ/8	19.0	483
OAP-40-055-04	40	1016	40.4	1026	5.5	140	10.7	4.0	102	3.9	99	1.94	49	0.1	λ/8	19.0	483
OAP-40-075-02	40	1016	40.5	1029	7.5	191	12.1	2.0	51	1.9	48	1.94	49	0.1	λ/8	19.0	483
OAP-40-025-02	40	1016	40.1	1019	2.5	64	5.0	2.0	51	1.9	48	1.51	38	0.1	λ/8	19.0	483
							13.3										
OAP-30-04-08	30	762	30.5	775	4.0	102	15.2	8.0	203	7.9	201	2.90	74	0.1	λ/8	24.0	61.0
OAP-30-015-08	30	762	30.3	770	1.5	38	10.5	8.0	203	7.9	201	1.82	56	0.1	λ/8	19.0	483
OAP-30-035-06	30	762	30.4	772	3.5	89	12.4	6.0	152	5.9	150	1.82	56	0.1	λ/8	19.0	483
OAP-30-055-04	30	762	30.5	775	5.5	140	14.3	4.0	102	3.9	99	1.82	56	0.1	λ/8	19.0	483
OAP-30-075-02	30	762	30.6	777	7.5	191	16.1	2.0	51	1.9	49	1.82	56	0.1	λ/8	19.0	483
OAP-30-025-02	30	762	30.1	765	2.5	64	6.7	2.0	51	1.9	49	1.41	36			19.0	48.3
							12.6										
OAP-25-035-06	25	635	25.4	645	3.5	89	14.8	6.0	152	5.9	150	1.90	56	0.1	λ/8	19.0	483
OAP-25-055-04	25	635	25.6	650	5.5	140	17.1	4.0	102	3.9	99	1.90	56	0.1	λ/8	19.0	483
OAP-25-075-02	25	635	25.7	653	7.5	191	19.3	2.0	51	1.9	49	1.90	56	0.1	λ/8	19.0	483
OAP-25-025-02	25	635	25.1	638	2.5	64	8.0	2.0	51	1.9	49	1.33	34	0.1		19.0	283
							8.6										
OAP-20-02-03	20	508	20.2	513	2.0	51	10.0	3.0	76	2.9	74	1.28	33	0.1	λ/8	10.0	25.4
OAP-20-03-02	20	508	20.2	513	3.0	76	11.4	2.0	51	1.9	49	1.28	33	0.1	λ/8	10.0	25.4

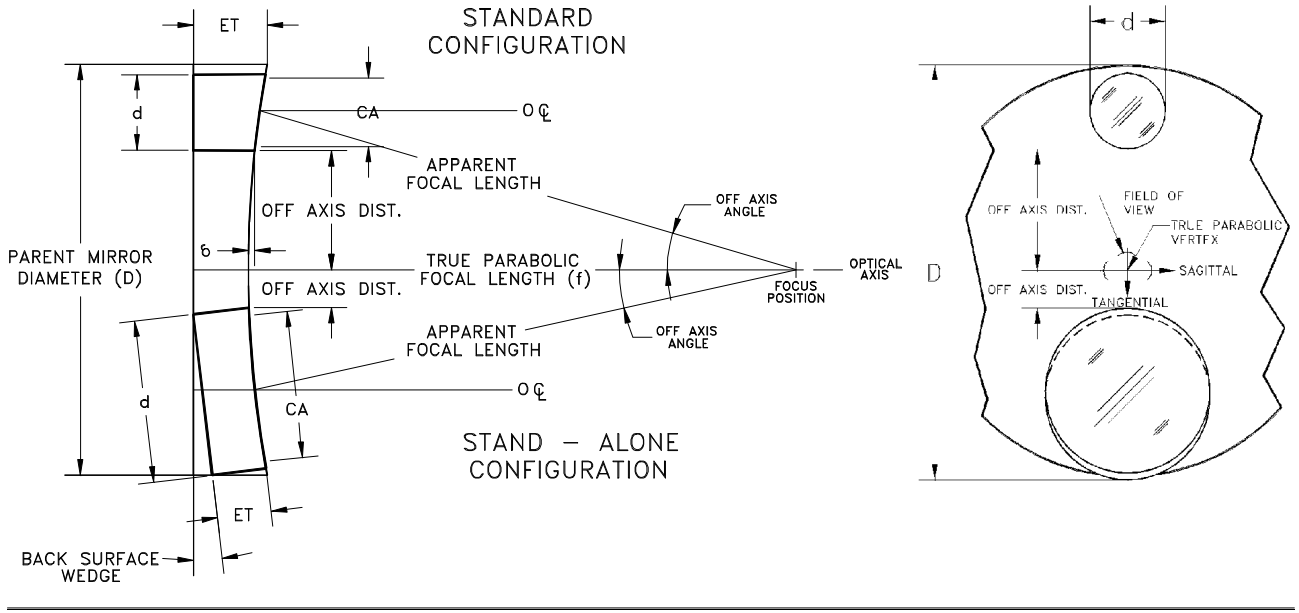
Order Number	Focal Length				Off-Axis Distance			Mirror Diameter		Clear Aperture		Outer Edge Thickness*		Optical Performance		Parent Mirror Usable Diameter	
	True Parabolic		Apparent		Inner Edge		Angle to Center							Standard Quality	High Quality "-Q" Surface Accuracy		
	in	mm	in	mm	in	cm	degree	in	mm	in	mm	in	mm	millirad.		in	mm
OAP-18-01-08	18	457	18.4	467	1.0	25	15.8	8.0	204	7.9	201	2.00	51	0.1	λ/8	18.0	457
OAP-18-03-06	18	457	18.5	470	3.0	76	18.9	6.0	152	5.9	150	2.00	51	0.1	λ/8	18.0	457
OAP-18-05-04	18	457	18.7	475	5.0	127	22.00	4.0	102	3.9	99	2.00	51	0.1	λ/8	18.0	457
OAP-18-06-03	18	45	18.8	478	6.0	153	23.5	3.0	76	2.9	74	2.01	51	0.1	λ/8	18.0	457
OAP-18-07-02	18	457	18.9	480	7.0	178	25.1	2.0	51	1.9	48	2.00	51	0.1	λ/8	18.0	457
OAP-12-017-04	12	305	12.3	312	1.7	43	17.5	4.0	102	3.9	99	1.88	48	0.1	λ/8	11.4	305
OAP-12-027-03	12	305	12.4	315	2.7	69	19.9	3.0	76	2.9	74	1.88	48	0.1	λ/8	11.4	305
OAP-12-037-02	12	305	12.5	318	3.7	94	22.2	2.0	51	1.9	48	1.88	48	0.1	λ/8	11.4	305
OAP-12-047-01	12	305	12.6	320	4.7	119	24.5	1.0	25	0.9	23	1.88	48	0.1	λ/8	11.4	305
OAP-06-02-03	6	152	6.5	165	2.0	51	32.5	3.0	76	2.9	74	1.66	41	0.2	λ/5	10.0	254
OAP-06-03-02	6	152	6.7	170	3.0	76	36.9	2.0	51	1.9	4.9	1.66	41	0.2	λ/5	10.0	254
OAP-06-04-01	6	152	6.8	173	4.0	102	41.1	1.0	25	0.9	2.3	1.66	41	0.2	λ/5	10.0	254
OAP-04-015-02	4	102	4.4	112	1.5	38	34.7	2.0	51	1.9	48	1.27	32	0.2	λ/5	7.0	178
OAP-04-025-01	4	102	4.6	117	2.5	64	41.1	1.0	25	0.9	23	1.27	32	0.2	λ/5	7.5	178
OAP-03-015-01	3	76	3.3	84	1.5	38	36.9	1.0	25	0.9	23	1.10	27	0.2	λ/5	5.0	127

Manufacturing Tolerances

- **Focal Length:** ±0.5%
- **Diameter:** +0.000" -0.010"
- **Off-Axis Distance:**
  ±0.02"(standard configuration)
  ±0.125" (stand-alone configuration)
- **Edge Thickness:**
  ±0.05" (12" focal length or less)
  ±0.10" (18" focal length or greater)
- **Surface Quality:** 60/40 (standard)

Surface Quality or Finish: A measure of the optical polish, specified by "scratch/dig" values denoting surface imperfections, as defined by Military Specifications, MIL-0-1383.

Scratch/Dig:
80/50 IR quality
60/40 Visible to IR (near UV)
40/20 UV to Visible Laser
20/10 UV and High Power Laser
Please note that 60/40 is standard for cataloged items.



NOTE: *What is a "Stand Alone" Aspheric Mirror?* If a rotationally symmetric "parent" cannot be manufactured because of size or material availability the aspheric section required has to be made as a sectional component. Aspherizing such Stand Alone components means the center point of an assumed sufficiently large rotational symmetric mirror has to be precisely simulated to assure the accuracy of the Stand Alone asphere. Shaping and precisely polishing such aspheres is a SORL specialty. SORL's precision of such difficult components is world famous.

- **Surface Accuracy:** Specified over 90% of the clear aperture area. (Typical Test Wavelength 0.6328 microns.) Deviation from perfect paraboloidal shape, specified as "peak to peak" (peak-to-valley) value in fractions of the interferometric test wavelength 0.6328 microns. Due to retro reflection at the surface, the interferometrically observable wavefront error is seen as twice the surface error. Therefore, the surface has twice the accuracy than interferometrically seen.

NOTE:

If you order by Order Number, you will receive an off-axis parabolic mirror with a surface accuracy of λ /8 or better.

The mirror will have an AlSiO coating for good reflectivity in the near IR and visible spectrum. For other coatings and wavelength ranges, consult page 13 and specify when ordering. Costs may differ from price list values.

Edge Thickness (ET): A mirror will typically be made from a blank having a 6:1 diameter-to-thickness ratio. For stand-alone mirrors, this is approximately correct. Standard OAPs sectioned from a larger diameter parent will be thicker. Edge thickness is given as reference only. Please clarify when ordering